(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 852 275 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
08.07.1998 Bulletin 1998/28

(51) Int. Cl.^{6}: E04D 12/00, E04D 13/16

(21) Application number: 98103743.5

(22) Date of filing: 28.04.1995

(84) Designated Contracting States:
AT BE CH DE FR LI NL

(30) Priority: 29.04.1994 DE 4415181

(62) Document number(s) of the earlier application(s) in accordance with Art. 76 EPC:
95106504.4 / 0 682 161

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Remarks:
This application was filed on 03 - 03 - 1998 as a divisional application to the application mentioned under INID code 62.

(54) Insulated ceiling composed of a plurality of layers

(57) A roof substructure for roofs decked with roof decking boards is made up, in the case of a couple roof to be insulated, of an exposed panel work (4) attached to the rafters (6); a film-type vapour barrier (8) laid on the exposed panel work (4); an insulating layer (10) based on mineral wool which is laid on the vapour barrier (8); and a film (24) which is water repellent and is open to diffusion which is laid on the insulating layer (10) and covers the latter. In this case, the insulating layer (10) is made up of at least two types of strips (18, 22) which are laid alternately individually and without gaps parallel to an edge of the roof, that is to say in a steep-pitched couple roof to the ridge (16) and to the eaves (12), the one type of strip (18) serving to absorb the roof load, introduced via base battens (20), of the roof parts located above the insulating layer (10), and having a far higher compression strength in relation to the other type of strip (22), serving purely insulating purposes, and being of a many times narrower design compared to the other type of strip (22), serving insulating purposes. In this case, the strips (18) for absorbing the load have a compression strength of at least 50 kN/m^2 and consist, like the strips (22) serving purely insulating purposes, solely of bonded mineral wool.

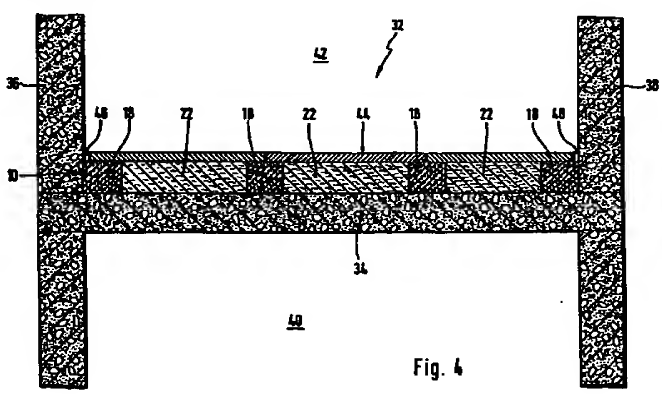

Fig. 4

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Description

The invention relates to a ceiling composed of a plurality of layers according to the preamble of Claim 1.

Effective insulation of roofs, walls, facades and ceilings, whether in the case of newly constructing buildings or also in the case of reconstructing old buildings, is nowadays basically indispensable for reasons of thermal and/or acoustic insulation. In the prior art, and in structural engineering in general, there exist therefore a large number of suggestions for how to insulate these parts of buildings.

For example, a roof insulation system has been disclosed in DE-A 28 39 767, in which thermal insulating sheets which can be rolled as an insulating layer parallel to the eaves are placed on loosely and held in their position at specific intervals by supporting planks which likewise run parallel to the eaves. Owing to the supporting planks which are made of wood and are laid with a mutual spacing of about 2 m, there are, however, several interruptions in the thermal insulating layer laid on the exposed panel work, thus resulting in cold bridges or heat bridges in each case in the region of the supporting planks, via which bridges cold or heat can pass from the roof decking into the inside of the building.

In total, the effect of the insulating layer in the insulation system according to DE-A 28 39 767 is therefore diminished. If the supporting planks were to be omitted, no satisfactory insulating effect of the thermal insulating sheets laid would be provided either since the pressure of the roof, consisting of its own weight, snow and wind load, would then compress the thermal insulating sheets.

A thermal roof insulation system has been disclosed in DE-A 34 35 648, which to a very great extent eliminates the disadvantage of the cold bridges or heat bridges caused by the wooden supporting planks. For this purpose, DE-A 34 35 648 proposes firstly laying sheets of insulating material running parallel to the ridge or eaves on the exposed panel work mounted on the rafters, supporting planks running between the sheets of insulating material approximately in accordance with DE-A 28 39 767. Further supporting planks running perpendicular to the eaves or to the ridge are then nailed to these supporting planks, and strips or sheets of insulating material are then again laid between these further supporting planks, which strips or sheets run turned through 90° relative to the first strips or sheets. The battens for the roof decking are then mounted on the supporting planks of the second layer of insulating material running perpendicular to the eaves. The continuous heat bridges or cold bridges caused by the supporting planks are thus indeed reduced to point-like places in the subject-matter of DE-A 34 35 648 where the supporting planks of the first and second insulating layers running perpendicular to one another intersect, thus certainly improving the insulating properties of this known roof substructure compared to DE-A 28 39 767, but these improved insulating properties have to be produced at the expense of a number of disadvantages:

For example, the insulation system according to DE-A 34 35 648 is expensive due to the multiplicity of supporting planks and insulating sheets, and it is additionally also time-consuming and thus expensive to construct since the roof virtually has to be completely thermally insulated twice, once with the insulating layer of the first layer and then with the insulating layer of the second layer running perpendicular thereto. Furthermore, the weight of roof is increased by the dual-layer construction with the increased number of supporting planks required. The provision of the additional supporting planks is also disadvantageous from the point of view of fire protection.

The problems specified above no longer exist in a roof substructure according to DE-A 36 15 109. In this known roof substructure, the supporting planks running between the individual sheets of insulating material and serving as a bearing construction for the subsequent roof load can be dispensed with. In the roof substructure according to DE-A 36 15 109, individual boards of insulating material, which are provided with a lamination on their topside, said lamination being open to diffusion but waterproof, are laid in such a way on the exposed panel work mounted on the rafters that partial regions of the lamination open to diffusion which project or overlap in each case at a longitudinal or transverse edge cover adjacent boards of insulating material, thus resulting in a lamination of the entire insulating layer which is formed in a mutually covering imbricated manner and is waterproof, but is open to diffusion. The bearing battens, which run perpendicular to the ridge and eaves and then receive the transverse battens for laying the roof decking boards, are then laid directly on this lamination which is water repellent, but open to diffusion. The bearing battens are attached by nailing through the lamination, through the material of the insulating boards and through the exposed panel work into the roof rafters located below.

This roof substructure of DE-A 36 15 109 with the advantage of an insulating layer over the entire surface has proved to be very expedient, but the insulating boards must, for statical reasons in order to absorb the roof load, have a compression strength of at least 50 kN/m^2 which makes such a roof substructure relatively expensive. At the same time, a relatively high bulk density is thus required, which affects the thermal conductivity in relation to the thermal insulating capacity. In order to obtain a good insulating effect, the thermal insulating boards must therefore be of appropriately thick design. To achieve a heat transmission coefficient k (k-value) of 0.42, for example, a thickness of at least 80 mm is thus required. Any improved k-values desired require correspondingly thicker thermal insulating boards. With an increasing thickness of the individual thermal insulating boards, however, the total roof load also rises considerably. Furthermore, thick boards of

this type are awkward to handle, to cut and to lay. Also, the thicker the thermal insulating boards are, an ever increasing shearing load results, which acts in the direction of the eaves and exerts bending moments on the attachment means of the insulating boards.

Furthermore, even though there are no inherent heat or cold bridges in DE-A 36 15 109, this roof substructure is built up of elements having a limited size (approximately 1120 x 600 mm). The size of these elements must be limited, for a single person could otherwise not handle them any more without problems or danger. This does, however, mean under practical circumstances that for decking the entire surface of a roof, a multiplicity of such insulating elements must be used. If, for example, insulating elements according to DE-A 36 15 109 having the above indicated dimensions are used for decking a roof of altogether 320 m^2, approximately 480 such insulating elements must be used to realize full-surface decking of the bearing formwork. The result is a multiplicity of joints between the individual elements, which run parallel and perpendicular to a roof edge, for example the eaves. Owing to prefabrication of the insulating elements and particularly to individual laying of the insulating elements, mutual contact between the individual abutting surfaces of the insulating elements in the area of these joints running parallel and perpendicular will never be fully guaranteed to be perfectly full-surface or without gaps, particularly in the case of inaccurate laying resulting in a multiplicity of heat or cold bridges in the insulating layer that are distributed over the entire roof.

It is conceivable to reduce the number of insulating elements per roof, for example to half by doubling their size, and thus reduce the number of individual butt joints, but then a single person would not be able any more to handle such an insulating element having a size of e.g. 2240 × 1200 mm without danger.

As already mentioned at the beginning, not only the insulation of facades and roofs, but also the insulation between storeys is increasingly gaining importance. Ceilings between single storeys, however particularly the ceiling between the top storey and the loft, are realized as layered insulated structures in the course of constructing new buildings, but also subsequently, particularly if higher demands to protection against impact sound are made, and/or if the space in the attic is to be used for storage or other purposes.

It is a known and widely common manner of proceeding in constructing a ceiling composed of a plurality of layers to lay a plurality of mutually spaced, parallel wooden beams on the supporting ceiling portion of the building. These wooden beams delimit between each other zones to be filled with insulating material which has the form of boards or sheets, or bulk material. On top of the wooden beams, and thus above the insulating layer, a top layer capable of bearing loads is then mounted, for example particle boards or gypsum plaster boards, which are screwed or nailed to the underlying wooden beams and form the cover for the layered ceiling capable of being walked on or otherwise bearing loads.

Although this type of construction is commonly applied, it suffers from a number of inherent disadvantages:

The wooden beams forming the supporting elements for the top layer are heavy and bulky parts which, particularly in the case of subsequent insertion of a ceiling composed of a plurality of layers to be constructed according to the known method, for example in the process of reconstructing an old building, often cannot even be transported to the location of installation through the inside of the building, i.e. the stairway, but require the expenses of transport to the location of installation by means of an external inclined hoist.

Laying the wooden beams is furthermore expensive as these must be screwed to the ceiling portion of the building. The reason for this is that wood, being a natural construction material, "works", which means that it can warp or tilt over the passage of time. In such a case, the top layer capable of bearing loads, i.e. the particle boards or the gypsum plaster boards or the like, will not he flushly supported any more and may locally bend when walked on, resulting in the occurrence of creaking or clattering sounds or the like. Screwing the wooden beams to the ceiling portion of the building, however, particularly in the case of concrete ceiling, requires expensive drilling and dowelling work.

If the ceiling portion of the building is uneven in itself, for example due to any major surface roughness in the concrete or due to the fact that the ceiling portion of the building is a wooden ceiling comprising more or less heavily warped boards, which is a common sight in old buildings, it must be ensured in a time-consuming manner, by underlying spacing wedges or the like when laying and fastening the wooden beams, that the top surfaces of all the wooden beams are within a horizontal plane after laying, in order to later on ensure correct laying of the particle boards or gypsum plaster boards likewise inside a horizontal plane.

Even if the insulating material introduced between the wooden beams fills the zones formed between the wooden beams closely fitting and essentially without a gap, the thermal and impact sound insulating properties of this known ceiling composed of a plurality of layers must be regarded as not always being satisfactory because the wooden beams have a low resistance against heat transmission on the one hand and a poor acoustic insulation capacity on the other hand. Impact sound is therefore directly transmitted from the top layer capable of bearing loads via the wooden beams to the underlying ceiling portion of the building and transmitted by the latter and radiated into a part of the building below, that is to say the storey underneath. Likewise, heat can travel from a part of the building situated underneath the layered ceiling through the ceiling portion of the building, the wooden beams providing poor

thermal insulation, and the top layer capable of bearing loads.

Finally it is quite a considerable disadvantage of the known insulated ceiling according to the above description that due to the wooden beams, the behaviour in fire of such a ceiling is poorer.

In contrast, the object of the present invention is to provide a roof substructure for roofs decked with roof decking boards, a method of producing such a roof substructure, and an insulated ceiling composed of a plurality of layers in such a way that, with a comparatively light layer of insulating material and, at the same time, improved thermal insulating capacity with smaller insulation thicknesses, a cost-effective roof substructure without any heat bridges or cold bridges can be achieved at small expense of time, money and work in the case of the roof substructure, and a ceiling which also is virtually free of heat bridges and also offers improved protection against impact sound can be achieved at small expense of time, money and work in the case of the insulated ceiling composed of a plurality of layers.

This object is technically achieved in terms of device by the features described in the characterizing part of Claim 1 or 9, respectively, and in terms of method by the features or measures described in the characterizing part of Claim 6.

For example, in the roof substructure according to the invention, the insulating layer is made up of at least two types of strips laid alternately individually and without gaps parallel to an edge of the roof, which can be laid individually and consecutively while made to contact each other without a gap. The one type of strip here serves to absorb the roof load of roof parts located above the insulating layer, is provided with a far higher compression strength and of a many times narrower design compared to the other type of strip, and manufactured from bonded mineral wool. The other type of strip is also manufactured from bonded mineral wool, primarily glass wool.

In the case of the insulated ceiling composed of a plurality of layers according to the invention, too, the insulating layer is made up of at least two types of strips arranged alternately and without gaps parallel to a building wall, which can be laid individually and consecutively while made to contact each other without a gap, the one type of strip serving as supporting elements for absorbing the loads introduced via a top layer, having a far higher compression strength in relation to the other type of strips, being of a many times narrower design, and consisting of bonded mineral wool, and the other strips preferably serving purely insulating purposes also consisting of bonded mineral wool, primarily glass wool.

Owing to the fact that the two types of strips may be laid individually and consecutively, care can be taken that the individual types of strips contact each other with a press-in fit and thus entirely without a gap. Owing to the design of the two types of strips in the form of bonded mineral wool, which has a certain fluffiness or elasticity particularly in the case of the type of strip serving purely insulating purposes, this results in contact of the two types of strips free of heat or cold bridges.

In other words, instead of the single, prefabricated board elements in the case of the roof insulating system according to DE-A 36 15 109, which generate the heat bridges or cold bridges, or instead of the supporting planks between the individual sheets of insulating material in the known insulated ceiling, in the roof substructure according to the invention or the ceiling according to the invention, respectively, the strips running between the strips preferably designed as pure insulating strips absorb the roof loads introduced via the bearing arrangement, for example base battens, or the static and dynamic live loads introduced via a top layer, for example particle boards or gypsum plaster boards.

It is essential, among others, that the strips for absorbing the load have a very high thermal insulating capacity and also impact sound insulation which is far better e.g. compared to supporting planks. It is an additional factor that the other strips, preferably designed as insulating strips, are not loaded, such that the latter can either have the same or an even better thermal insulating capacity. Since the strips for absorbing the load are of a many times narrower design compared to the other strips preferably serving purely insulating purposes, the reduced thermal insulating capacity in the region of the load-absorbing strips - the reduction being relatively small in any case - occurs in a region taking up a small percentage of the entire roof surface. In this case, the strips preferably serving purely insulating purposes - approximately as when using wooden supporting planks - can be selected to have optimum properties in respect of their thermal insulating capacity since they are not involved in absorbing the roof load. As a result, it is once again possible to reduce the overall thickness of the insulating layer without having to tolerate a poorer k-value when doing so. The multiplicity of constructive joints running parallel and perpendicular to a roof edge as are present in DE-A 36 15 109 are also eliminated, which also positively contributes to improve the k-value. Finally, the use of an essentially relatively light additional insulating layer allows a significant reduction in material costs, and the load-absorbing strips provide a cost saving in respect of special supporting planks and their wage-intensive attachment.

When building up an insulated ceiling composed of a plurality of layers according to the invention, the strips for absorbing the load in addition also have a very good impact sound insulating capacity besides the very high thermal insulating capacity which is far better compared with that of the usual beams.

The ceiling according to the invention provides the further advantage of a significant reduction in material costs, and use of the load-absorbing strips provides quite considerable cost saving due to elimination of the wooden beams which are awkward to handle and their

labour, time and wage intensive attachment.

The elimination of the wooden beams as supporting elements results in a considerable improvement of the impact sound insulation in the ceiling according to the invention. The top layer capable of bearing loads is basically laid floatingly on the insulating layer; between the top layer and the ceiling portion of the building, there are no elements which would transmit impact sound as the wooden beams are replaced with the load-absorbing strips consisting of compression-resistant mineral wool.

Any unevenness of the ceiling portion of the building on which the two types of strips for forming the insulating layer and the bearing layer are laid is compensated by the elasticity of the mineral wool material used, wherefore expensive aligning work is not required to finally arrive at a top layer of particle boards or the like having a proper horizontal alignment.

Owing to the elimination of the wooden beams, fire protection is also improved in the layers ceiling composed of a plurality of according to the invention.

The method according to the invention for constructing a roof substructure essentially comprises the steps of building up the insulating layer from at least two types of strips which are laid alternately individually and without gaps parallel to an edge of the roof, the one type of strip serving to absorb the roof load, introduced via a bearing arrangement, of the roof parts located above the insulating layer, and having a far higher compression strength in relation to the other type of strip, and being of a many times narrower design compared to the other type of strip. Furthermore, the strips for absorbing the load are arranged above the bearing formwork with a mutual spacing which corresponds to or is slightly smaller than the width of the other strips, the other strips then being pressed in without gaps between the load-absorbing strips in order to form a continuous insulating layer which is free of heat bridges.

What is essential here is that the strips serving purely insulating purposes are pressed in between the load-absorbing strips without a gap in order to form the continuous insulating layer free of heat bridges. This pressing in free of gaps is made possible by the fact that both types of strips consist of bonded mineral wool, such that the load-absorbing strips may be arranged with a mutual spacing which corresponds to or is slightly smaller than the width of the other strips, with the fluffiness and elasticity of the strips serving for insulating purposes making it possible to press in these strips between the load-absorbing strips without a gap and closely fitting and thereby form the continuous insulating layer without heat bridges.

The method according to the invention can be applied analogously in producing or constructing the insulated ceiling composed of a plurality of layers according to the invention, with the starting edge or reference edge, however, not being a roof edge but a building wall.

Advantageous further developments of the invention emerge from the respective subclaims.

The strips for absorbing the load have a compression strength of at least 50 kN/m^2. As a result, it is ensured that, despite the width of the load-absorbing strips being many times smaller compared to the other strips preferably serving purely insulating purposes, the roof loads introduced via the bearing arrangement, or the static and dynamic loads generated by pieces of furniture, walking on etc. introduced via the top layer, can reliably be absorbed and distributed without said loads, while doing so, excessively pressing in the load-absorbing strips and thus also the other strips located between them.

At least the strips of bonded glass wool can be produced in either sheet or board form. However, the sheet form is preferred since this allows more rapid laying between the load-absorbing insulating strips.

If the roof substructure according to the invention is to be constructed for a steep-pitched roof, the two types of strips are laid parallel to that edge of the roof which is defined by the ridge and/or eaves. As a result, the load-absorbing strips can be used directly for attaching the bearing arrangement, designed as base battens, for the remaining roof construction, that is to say battens and roof decking boards. In this case, the strips for absorbing the are attached to the exposed panel work more or less fixedly depending on the roof slope, which can be carried out, for example, by point-type tacking using staples or the like. This is begun starting from the ridge, by attaching the first load-absorbing strip of higher bulk density parallel to said ridge on the exposed panel work covered by the vapour barrier. The second load-absorbing strip of higher bulk density then follows parallel to the first and parallel to the ridge, specifically with a spacing which corresponds to the width - with a slight underdimension - of the strip serving purely insulating purposes. The strip made of bonded glass wool serving purely insulating purposes is then pressed or clamped into the strip-shaped zone thus created. The third strip of higher bulk density then follows, and so on until the entire roof surface has the alternating insulating layer.

The top layer of the ceiling according to the invention preferably has a bending strength of approximately 12 N/mm^2 to 18 N/mm^2, in a particularly preferred manner approximately 15 N/mm^2. It is understood that the bending strength lastly depends on the thickness of the materials used for the top layer as well as the types of material. However, bending strength values contained in the above mentioned range represent the most favourable compromise between bending strength and thus favourable, large-area load distribution on the one hand, and costs or ease of handling of the boards forming the top layer on the other hand. The particularly preferred bending strength value of approximately 15 N/mm^2 results e.g. in the case of particle boards V100 having a thickness of 22 mm, which are plates that are cost-effective and still allow for ease of handling in the

commercially available dimensions of 100 x 200 mm at a thickness of 22 mm.

In the method according to the invention, in laying the sheets or boards of mineral wool serving for insulating purposes, any excess lengths projecting in the region of an end face of the roof can advantageously be cut off. These cut-off excess lengths can then form the beginning when laying the next strip serving insulating purposes. As a result, laying is possible which is to a very great extent without waste and thus without losses.

Further details, aspects and advantages of the present invention emerge from the following description with reference to the drawing, in which:

Figure 1 shows a sectional illustration along line I-I in Figure 3 to illustrate a construction of a roof substructure according to the invention;

Figure 2 shows a sectional illustration along line II-II in Figure 1 and 3; and

Figure 3 shows a perspective and, in some parts, cutaway view of a roof substructure according to the invention.

Figure 4 shows a vertical section through an insulated ceiling composed of a plurality of layers according to the present invention.

The following description of an embodiment of a roof substructure according to the present invention is given with reference to a practical example, in which a steep-pitched couple roof is insulated using the roof substructure according to the invention. The insulation of other roof types, however, is equally possible.

A roof substructure denoted in total by 2 in the drawing has the construction which can be seen, in particular, in Figures 1 and 2. In the example illustrated, the roof substructure serves to insulate a couple roof decked with roof decking boards. Couple roofs are distinguished in a known manner by a exposed panel work 4 which is designed, for example, in the form of tongue-and-groove boards which are nailed to the individual rafters 6 over the entire surface. The exposed panel work 4 is followed by a covering layer 8 which not only serves as a vapour barrier, but also provides the required draught-proofing. A reinforced bitumen roof sheeting mat V13 can be used, for example, as the covering layer 8 which is nailed at seams and joints to overlap in a concealing manner.

An insulating layer 10 is then built up on the covering layer 8. As can best be seen in Figures 1 and 3, the insulating layer 10 consists of at least two types of laid strips which are laid, according to Figures 1 and 3, between a roof eaves 12 or an eaves beam 14 at that point and a roof ridge 16 without gaps and alternately parallel to said roof ridge and to the eaves 12. In this case, the one type of strip 18 serves to absorb the roof load introduced via base battens 20 serving as a bearing arrangement for the remaining roof construction (in particular battens 21 and roof decking boards), and the other type of strip 22 serves purely insulating purposes. As can best be seen from Figures 1 and 3, in this case the strips 18 for absorbing the load are of a many times narrower design compared to the strips 22 serving purely insulating purposes. For example, the strips 18 have a width of 150 mm and the strips 22 have a width of 600 mm.

The strips 18 for absorbing the load have a compression strength of at least 50 kN/m^2 and consist, in a preferred design, of bonded mineral wool. The strips 22 located between them and serving purely insulating purposes preferably also consist of bonded glass wool.

A film 24 which is water repellent and open to diffusion is laid in sheets in an overlapping manner on the insulating layer 10 (Figure 2). The individual battens of the base battens 20 are predrilled in the region of the load-absorbing strips 18 and nailed through the insulating layer 10 with the rafters 6 located below it by means of rafter nails 26. The base battens 20 then serve to receive the battens 21 for the roof decking.

To produce the roof substructure 2 according to the invention or the insulating layer 10, the procedure is as follows:

The laying of the insulating layer 10 begins at the ridge 16 in the direction of the eaves 12. When the required preparatory work has been completed, i.e. when the exposed panel work 4 has been attached to the rafters 6 and the covering layer 8 has been mounted thereon, a row of load-absorbing strips 18 is firstly attached to the corresponding rafters 6 through the exposed panel work 4 and through the covering layer 8 at that point. For this purpose, the load-absorbing strips 18 can be tacked on, for example, using so-called staples. In this case, the spacing between the individual strips 18 is slightly smaller (e.g. 1 cm) than the width of the strips 22 to be laid between the load-absorbing strips 18 and serving purely insulating purposes, in order thus to achieve a clamping effect of the strips 22 between the strips 18 which is free of heat bridges. When the last strip 18 has been tacked to the rafters 6 through the covering layer 8, the strips 22 serving purely insulating purposes are pressed into the zones between the load-absorbing strips 18 with a press-in fit and without joints. The spacing between the last load-absorbing strip 18, seen in the direction of the eaves, and the eaves beam 14 generally does not correspond precisely to the width of a strip 22 serving purely insulating purposes, but is usually smaller to a greater or lesser extent, as indicated in Figures 1 and 3. The last strip 22 of pure insulating material, located in the region of the eaves, therefore has to be cut to an appropriately narrower size.

Another possibility of building up the insulating layer 10 is to tack the load-absorbing strips 18 on in the rafters 6 through the covering layer 8 as the insulating layer

gradually "travels" in the direction of the eaves 14. More precisely, the first load-absorbing strip 18 is firstly tacked on starting from the ridge 16. The second load-absorbing strip 18 is subsequently tacked on with a suitable spacing (see above) from the first load-absorbing strip 18, and the first zone between these strips 18 is filled with the first strip 22 serving the insulating purposes. The third load-absorbing strip 18, seen from the ridge 16, is then tacked on with a suitable spacing from the second load-absorbing strip 18, and the second zone between these strips 18 is filled with the second strip 22 serving the insulating purposes, and so on.

The load-absorbing strips 18 are available in a specific length, for example 2 m, a specific width of, for example, 150 mm and appropriate thicknesses of, for example, 80 to 180 mm, graded in increments of 20 mm. The width of the strips 22 serving purely insulating purposes is, for example, 600 mm and their thickness corresponds to the thickness of the respective load-absorbing strips 18, that is to say, for example, is within the range of 80 to 180 mm in increments of 20 mm. The strips 22 serving purely insulating purposes can be built up of insulating material in board form or sheet form. The use of glass wool in sheet form is preferred, which can be cut off in the case of an excess length projecting at the end face and forms the beginning at that point when the next strip 22 serving insulating purposes is laid. Laying of the sheet-type or board-type glass wool material to build up the strips 22 serving purely insulating purposes is thus possible to a very great extent without waste and without losses.

When the insulating layers 10 have been built upon both sides of the roof according to one of the procedures mentioned, the gap remaining in the region of the ridge 16 between the two load-absorbing strips 18 at that point is also stuffed with insulating material 28. Subsequently, the film 24 which is open to diffusion is laid in sheet form with appropriate overlaps 30 on the two insulating layers 10 over the entire insulating or roof surface and is sealed off in the regions of the overlaps 30 using self-adhesive strips. In this case, the film 24 and its individual sheets on one side of the roof extend by a specific amount beyond the ridge 16 onto the other side of the roof and vice versa so that the layer which is formed by the film 24 and is open to diffusion, but is waterproof, is closed over the entire surface. As already mentioned, the individual battens of the base battens 20 are then predrilled in the region of the load-absorbing strips 18 and the base battens 20 are nailed using the rafter nails 26 through the material of the load-absorbing strips 18 into the material of the individual rafters 6. The base battens 20 then receive the bearing battens 21 for the roof decking.

The introduction of the roof load onto the rafter zone of the roof, formed by the rafters 6, thus takes place via the base battens 20 and the load-absorbing strips 18. Since the load-absorbing strips 18 have a compression strength of at least 50 kN/m^2, they also have sufficient compression strength to absorb the roof load - composed of the load caused by roof parts located above the insulating layer 10 and snow and/or wind load - and introducing it into the rafters 6 without any substantial compression of the load-absorbing strips 18 and thus of the strips 22 serving purely insulating purposes occurring when doing so.

It is also possible to use the combinations, according to the invention, of compression-resistant strips made of bonded mineral wool and sheets serving only purely insulating purposes and likewise made of bonded mineral wool, but having a far lower bulk density for insulating facades on buildings. In this case, instead of the basic battens 20, as in the couple roof described, a lattice structure is laid over the entire roof surface, which lattice structure spans the insulating surface and is embedded in an undercoat rendering. Subsequently, the entire surface is provided with an exterior rendering so that the layer of external rendering thus formed is then supported via the lattice structure on the individual compression-resistant strips.

Furthermore, the combination according to the invention can also be used advantageously for facade constructions in which claddings, such as shingles attached to batten grids or prehung renderable bearing panels are used. In the exemplary use of bearing panels, the facade construction can also be designed to be ventilated, specifically by the compression-resistant strips being of thicker design than the strips serving purely insulating purposes, so that ventilation slots remain free between the bearing panels and the insulating sheets. As shown by the further examples of use specified, the combination according to the invention can be used universally. In general terms, the above statements in respect of a roof insulation using the roof substructure according to the invention apply essentially also to a facade insulation. The same advantages can be achieved, that is to say advantages in respect of cost saving, weight reduction, simple construction, continuous freedom from heat bridges and non-flammability of the insulating layer.

The structure of an insulated ceiling composed of a plurality of layers according to the invention shall now be explained by reference to Figure 4. The same reference numerals as in Figures 1 to 3 denote identical or corresponding structural elements or components in Figure 4, and another detailed description will not be given.

An insulated ceiling composed of a plurality of layers according to the present invention, denoted in total by 32 in Figure 4, comprises a supporting ceiling portion 34 of the building, for example of concrete or the like, extending between two building walls 36 and 38 and separating a lower room 40 from an upper room 42 situated above it. The ceiling 32 furthermore comprises an insulating layer 10 laid on the top side of the ceiling portion 34, and a top layer 44 capable of bearing loads arranged above the insulating layer 10, for example in the form of particle boards, gypsum plaster boards, light

building boards or the like.

The top layer 44 is supported against the ceiling portion 34 by the strips 18 serving as supporting elements which rest on the ceiling portion 34 of the building, and running inside the insulating layer 10. The supporting elements are arranged so as to be running parallel at a mutual spacing on the ceiling portion 34 and define between each other zones which are filled in with the other strips 22 serving purely insulating purposes.

Here, as well, the supporting elements 18 are strips of bonded mineral wool having a far higher compression strength in relation to the strips 22 of the insulating material serving purely insulating purposes, and being of a many times narrower design.

The insulating layer 10 consequently consists - as in the case of the roof substructure according to the invention - of two types of strips arranged alternately and essentially parallel to at least one of the building walls 36 and 38, which may be laid consecutively so as to contact each other without a gap. For example, initially the mineral wool strip 18 shown on the left in Figure 4 is laid on the ceiling portion 34 along along the building wall 36 to form the first supporting element. Here care should be taken that the supporting element or the mineral wool strip 18 forming the supporting element abuts against the building wall 36 as closely fitting as possible and without a gap. It may be of advantage if the supporting elements are at least provisionally fixed on the top side of the ceiling portion 34 until the entire insulating layer 10 has been built up of the alternately arranged strips 18 of the supporting elements and the strips 22 of the insulating material arranged in between them. To this end, the supporting elements or the strips 18 forming the supporting elements may, for example, be glued to the ceiling portion 34 in point or strip-type connection.

When the first supporting element has been laid essentially without joints or gaps along the building wall 36, there result two basic manners of further proceeding or laying possibilities in order to obtain the insulating layer 10 (in analogy with the two possible procedures when building up the roof substructure according to the invention):

In the first procedure, the supporting element shown second from the left in Figure 4 is laid on the ceiling portion 34 parallel to the first supporting element at a distance therefrom, and in a given case its position is fixed on the ceiling portion 34 in point or strip-type connection by glueing or the like. The intervals between neigbouring supporting elements are preferably identical, in a particularly preferred manner they are somewhat less than the width of the strips 22 of bonded mineral wool, preferably glass wool, forming the insulating material. When the second supporting element has been laid, and in a given case its position has been fixed on the ceiling portion 34, the first strip 22 of insulating material shown on the left side in Figure 4 is fitted in between the two supporting elements. If the interval between the two supporting elements is slightly smaller than the width of the strip 22 forming the insulating material, then the insulating material will fit closely and without any gap or joint between the two supporting elements. Heat or cold bridges at the boundary surfaces between the supporting elements and the insulating material are hereby prevented. When the first strip 22 of the insulating material has been inserted between the two supporting elements, the supporting element shown third from the left in Figure 4 is arranged on the ceiling portion 34 and in a given case its position is fixed, after which the strip 22 of the insulating material shown in the middle in Figure 4 is inserted etc., until the entire ceiling portion 34 between the two building walls 36 and 38 is entirely covered with the insulating layer 10 of alternately arranged supporting element strips 18 and strips 22 of insulating material.

Another possibility of building up the insulating layer 10 is to initially lay all of the supporting elements at a suitable mutual spacing on the ceiling portion 34 in a single work step and provisionally fix them if this is necessary, after which the insulating material is then inserted, preferably press-fitted between the supporting elements.

Subsequently, the top layer 44 capable of bearing loads is laid floatingly on the insulating layer 10, preferably leaving uninterrupted gaps 46 and 48 between the building walls 36 and 38 and the edge of the top layer 44, which gaps may possibly be filled in with a felt strip or the like. Due to floatingly laying the top layer 44, the top layer 44 does not contact the building walls 36 and 38 and consequently there is no transmission of impact sound via building walls 36 and 38 from the upper room 42 into the lower room 40. Absorption and passing on of loads received by the top layer 44 to the ceiling portion 34 is performed by the strip-shaped supporting elements consisting of bonded mineral wool. These strips have a compression strength of at least 50 kN/m^2 in order to be able to properly absorb received loads and to also distribute point-shaped loads over a large surface. Hereby it is ensured that the intermediate strips 22 of the insulating material, which are adjusted to be soft, will not be compressed and consequently lose thermal insulating capacity.

Because of the demanded compression strength of at least 50 kN/m^2 for the supporting elements, the mineral wool material used herefor must be adjusted to a correspondingly higher bulk density, whereby the insulating capacity of the supporting elements is diminished in relation to that of the insulating material, however still essentially better than that of the wooden beams formerly used as supporting elements. For the rest, the strips 18 of the supporting elements are of a many times narrower design compared to the strips 22 of the insulating material, such that the percentage of the supporting elements in the entire insulating layer 10 is comparatively small, such that the thermal insulating

capacity of the supporting elements which is only slightly poorer than that of the insulating material does not make too much of a difference, either.

Due to floating lay of the top layer 44 on the insulating layer 10 on the hand, and the absence of construction elements in the insulating layer 10 capable of resonating or transmitting sound waves, the ceiling 32 according to the invention has very good impact sound insulation. Due to the fact that the insulating material is preferably press-fitted between the supporting elements, i.e. without a gap, there are practically no heat or cold bridges in the insulating layer 10, so that the thermal insulating capacity of the ceiling 32 according to the invention is vastly improved compared with a conventional insulated ceiling composed of a plurality of layers. Due to the absence of any flammable elements in the insulating layer 10, fire protection of the ceiling 32 according to the invention is also improved.

The strips 18 forming the supporting elements and the strips 22 of the insulating material serving purely insulating purposes preferably are dimensioned as already indicated above with reference to the roof substructure according to the invention. The strips 22 of the insulating material may be made up of insulating material in board or strip form. Use of glass wool in strip form, which in the case of excess lengths can simply be cut off to form the beginning when laying the next strip 22 of the insulating material, is preferred. Laying of the insulating material to a very great extent without waste and thus without losses is thereby possible. The board form of the insulating material can, however, also be of advantage, for example under confined installing conditions.

Thanks to the fact that the supporting elements are shipped in lengths of e.g. two metres and consist of bonded mineral wool, the supporting elements may be carried and handled with ease even in narrow stairways or the like, and they are also well suited for laying on the ceiling portion 34 when the installing conditions are confined. Rapid and cost-saving construction of the insulating layer 10 or of the entire ceiling 32 is thus made possible.

Thanks to the fact that the supporting elements also consist of the strips 18 of bonded mineral wool, and thus - in spite of their compression strength of at least 50 kN/m^2 - have a certain resilience at least in the surface area, any roughness or unevenness on the side of the ceiling portion 34 where the insulating layer 10 is built up does not hamper this construction, because due to the flexibility of the insulating material which is anyway very good, and also due to the flexibility of the supporting elements contained in a certain range, such unevenness or roughness is compensated, which later on results in the top layer 44 resting on the supporting elements 18 in proper horizontal alignment.

The insulated ceiling 32 composed of a plurality of layers according to the invention is thus essentially characterized in that

a) it has very good thermal insulating capacity as it is essentially free of heat bridges because of the flush contact of the insulating material with the supporting elements without gaps, or contact of the supporting elements with the building walls 36 and 38;

b) it offers very good protection against impact sound as between the top layer 44 and the ceiling portion 34, there are no materials in the area of the insulating layer 10 which might enable good sound transmission and as the top layer 44 is laid floatingly on the insulating layer 10;

c) it can be produced in a more cost-effective manner due to easy handling of the supporting elements, and due to the absence of the expensive wooden beams; and

d) it offers improved fire protection due to the absence of flammable materials in the insulating layer 10.

Claims

1. Insulated ceiling composed of a plurality of layers, having:

   a supporting ceiling portion (34) of the building;

   an insulating layer (10) laid on the ceiling portion (34) of the building; and

   a load-distributing top layer (44) arranged above the insulating layer (10), which is supported against the ceiling portion (34) of the building by supporting elements resting on the ceiling portion (34) of the building and extending in the plane of the insulating layer (10), *characterized in that*

   the insulating layer (10) is made up of at least two types of strips (18, 22) arranged alternately and essentially parallel to a building wall (36, 38), which stripes can be laid individually and consecutively such as to contact each other without any gaps,

   the one type of strip (18) serving as supporting elements to absorb the loads, introduced via the top layer (44), having a far higher compression strength in relation to the other type of strip (22), being of a many times narrower design, and consisting of bonded mineral wool; and

   the other strips (22), preferably serving purely insulating purposes, also consisting of bonded mineral wool, primarily glass wool.

2. Ceiling according to Claim 1, characterized in that

the strips (18) serving as supporting elements have a compression strength of at least 50 kN/m^2.

3. Ceiling according to Claim 1 or 2, characterized in that the strips (22) serving purely insulating purposes are laid in roll or board form.

4. Ceiling according to Claim 1, 2 or 3, characterized in that the top layer (44) has a bending strength of approximately 12 N/mm^2 to 18 N/mm^2, preferably approximately 15 N/mm^2.

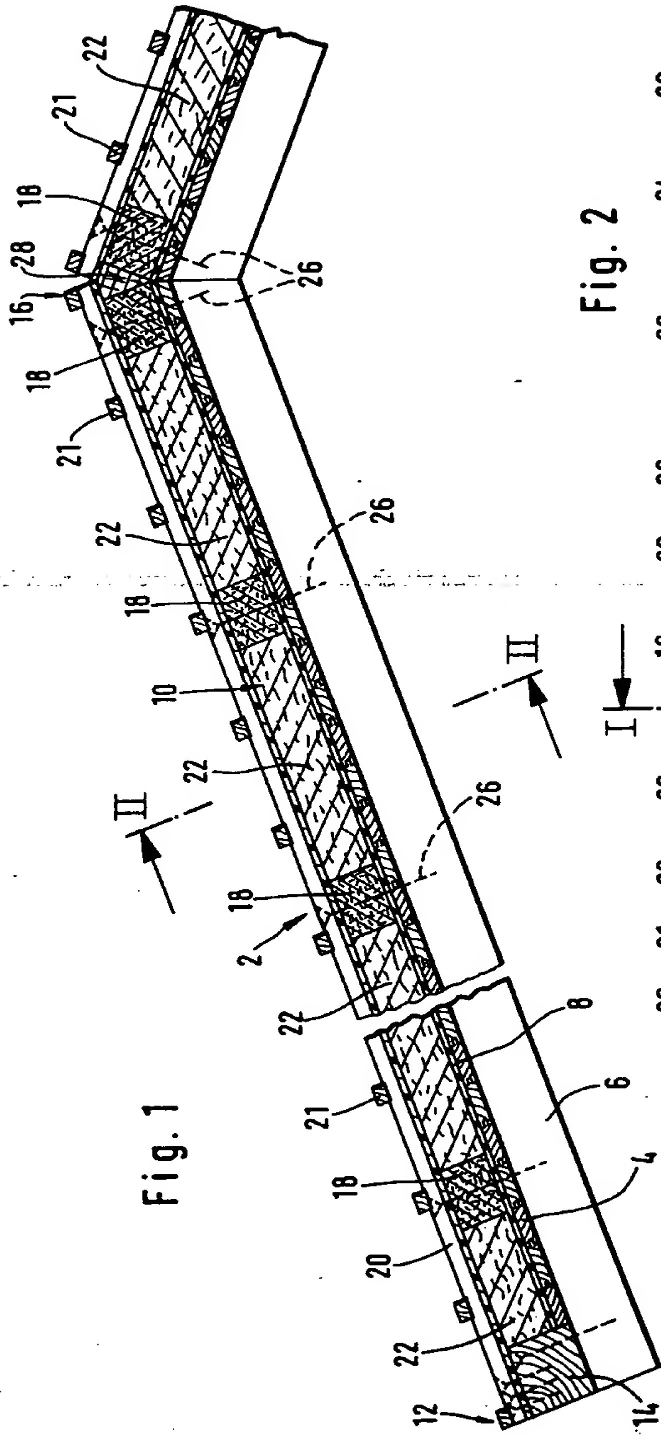
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Fig. 1

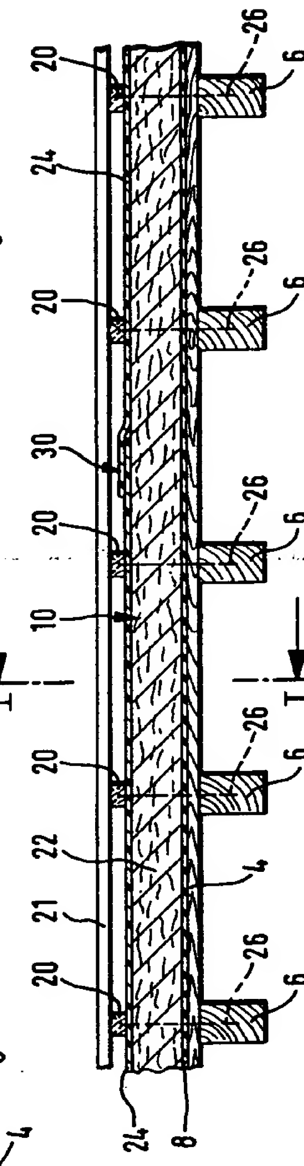
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Fig. 2

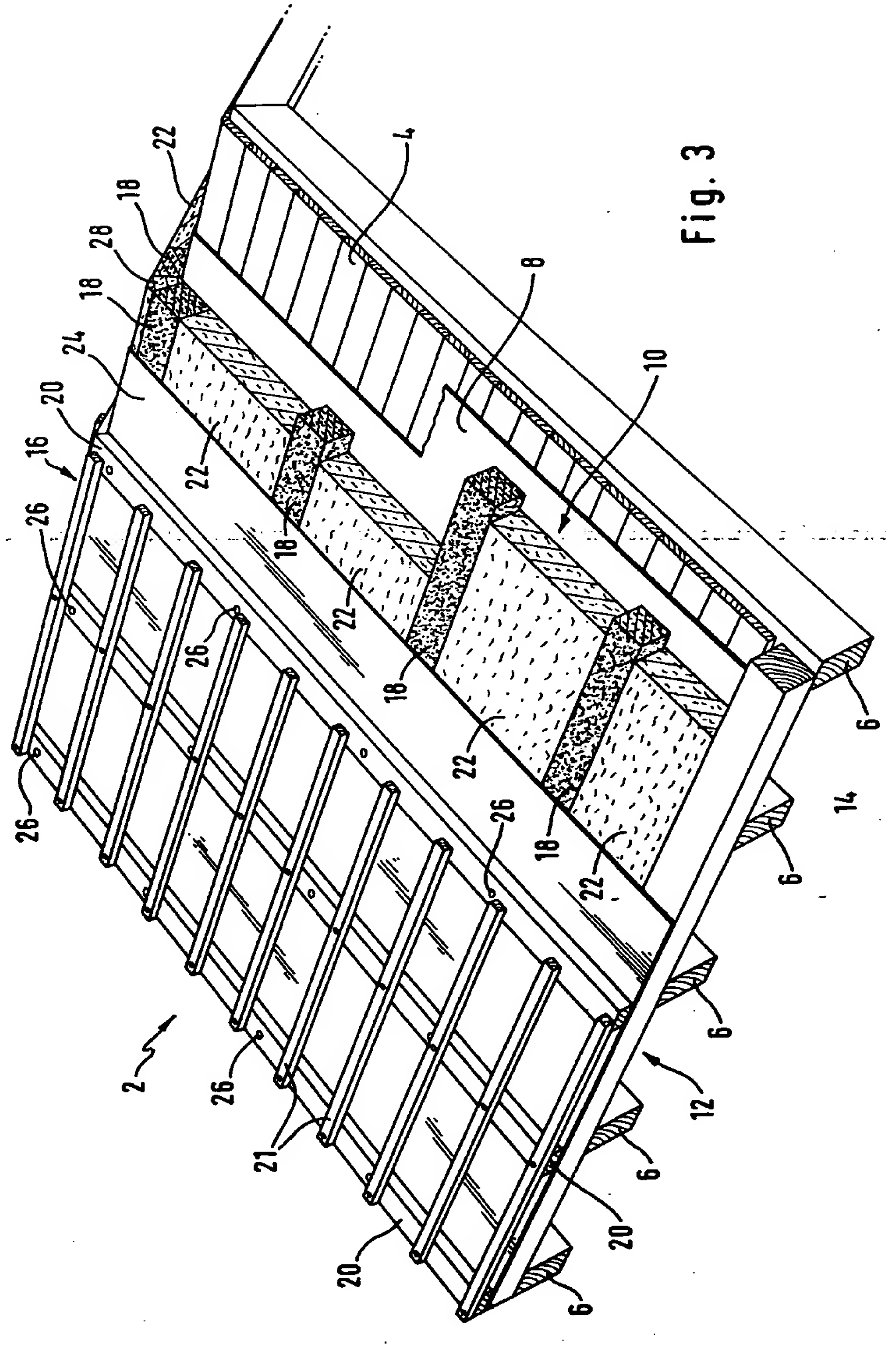

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Fig. 3

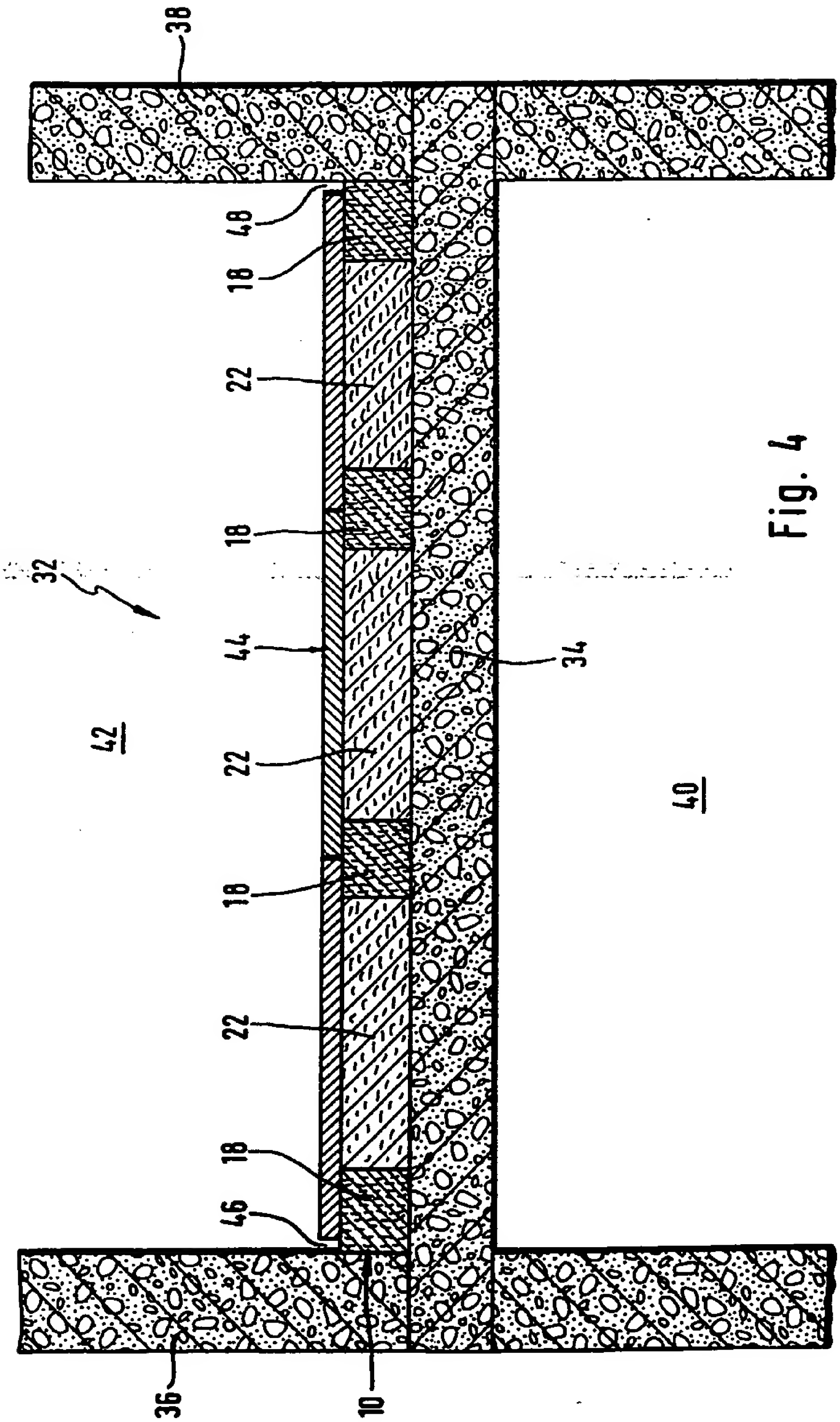

Fig. 4